

MATERIAL SAFETY DATA SHEET

1. SUBSTANCE AND SOURCE IDENTIFICATION

National Institute of Standards and Technology
Standard Reference Materials Program
100 Bureau Drive, Stop 2320
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SRM Number: 3151
MSDS Number: 3151
SRM Name: Silver Standard Solution

Date of Issue: 17 May 2006

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Description: This Standard Reference Material (SRM) is intended for use as a primary calibration standard for the quantitative determination of silver. One unit of SRM 3151 consists of five 10 mL sealed borosilicate glass ampoules of an acidified aqueous solution prepared gravimetrically to contain a known mass fraction of silver. The solution contains nitric acid at a volume fraction of approximately 10 %.

Material Name: Silver Standard Solution

Other Designations:

Silver: Argentum; elemental silver; silver metal.

Silver Nitrate: Silver mononitrate; nitric acid silver (I) salt; lunar caustic.

Nitric Acid: Aqua fortis; hydronitrate; hydrogen nitrate; azotic acid; engraver's acid.

2. COMPOSITION AND INFORMATION ON HAZARDOUS INGREDIENTS

| Component | CAS Registry | EC Number (EINECS) | Concentration (%) |
|----------------|--------------|--------------------|-------------------|
| Nitric Acid | 7697-37-2 | 231-714-2 | 10 |
| Silver Nitrate | 7761-88-8 | 231-853-9 | 1.6 |
| Silver | 7440-22-4 | 231-131-3 | 1 |

EC Classification, R/S Phrases: Refer to Section 15, Regulatory Information.

3. HAZARDS IDENTIFICATION

NFPA Ratings (Scale 0-4): Health = 4 Fire = 0 Reactivity = 2

Major Health Hazards: Both nitric acid and silver nitrate can cause severe or fatal damage if inhaled, swallowed, or absorbed through the skin. Chronic exposure to silver dust or compounds may cause permanent blue-gray discoloration of skin or eyes. "Metal fume fever" may occur (flu-like symptoms after inhaling metal dust).

Physical Hazards: None documented for this mixture; glass container may shatter.

Potential Health Effects

| | |
|----------------------|---|
| Inhalation: | Both nitric acid and silver nitrate, if inhaled, can damage the mucous membranes and respiratory tract, causing spasm, inflammation of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Symptoms may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. Inhalation of silver dust may cause irritation. Symptoms of “metal fume fever” from inhalation of metal dust include muscle aches, nausea, weakness, fatigue, headache, chills, and fever. |
| Skin Contact: | Both nitric acid and silver nitrate can cause severe skin burns. Effects of acid burns may be delayed. Silver nitrate burns may appear black. Chronic exposure to silver may cause argyria (permanent blue-gray discoloration of skin or other tissues). Silver may be absorbed through broken skin. Allergic sensitization to silver or other metals may occur. |
| Eye Contact: | Both nitric acid and silver nitrate can cause severe eye irritation, corneal burns, permanent eye damage, or blindness. Silver dust can cause eye irritation. Chronic exposure to silver compounds may cause permanent blue-gray discoloration of the eyes or decreased night vision. |
| Ingestion: | Both nitric acid and silver nitrate can cause severe burns and damage to the GI tract. Chronic ingestion of silver may cause argyria (permanent blue-gray discoloration of skin or other tissues). Repeated or prolonged ingestion of inorganic nitrates can cause anemia, kidney disease, and blood abnormalities. |

Medical Conditions Aggravated by Exposure: The mixture may aggravate pre-existing disorders of the eyes, skin, GI tract, and respiratory tract.

Listed as a Carcinogen/ Potential Carcinogen:

| | Yes | No |
|--|-------|--------------|
| In the National Toxicology Program (NTP) Report on Carcinogens | _____ | <u> X </u> |
| In the International Agency for Research on Cancer (IARC) Monographs | _____ | <u> X </u> |
| By the Occupational Safety and Health Administration (OSHA) | _____ | <u> X </u> |

4. FIRST AID MEASURES

Inhalation: Move the person to fresh air immediately. Qualified medical personnel may start CPR or give oxygen if necessary. Get medical aid at once, and bring the container or label.

Skin Contact: Remove contaminated clothing and shoes. Flush affected skin with water for at least 15 minutes, then wash thoroughly with soap and water. If burns are severe or if skin irritation persists, get medical aid and bring the container or label. Wash contaminated clothing before reusing.

Eye Contact: Remove contact lenses (if any). Do not allow victim to rub eyes or keep eyes closed. Flush eyes with large amounts of running water for at least 30 minutes, keeping eyelids open and raising lids to remove all chemical. Get medical aid at once, and bring the container or label.

Ingestion: Contact a poison control center immediately for instructions. Wash out mouth with water, but do not induce vomiting. Get medical aid at once, and bring the container or label.

Note to Physician (Nitric Acid): Wash affected skin with 5% solution of sodium bicarbonate (NaHCO₂). Activated charcoal is of no value. Do not give bicarbonate to neutralize the material.

5. FIRE FIGHTING MEASURES

Fire and Explosion Hazards: Although nitric acid and silver nitrate do not burn, both are powerful oxidizing agents that can react with combustible materials to cause fires. Silver nitrate also reacts with alcohol to produce explosive vapors. Silver dust or powder (not present in this mixture) is flammable.

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire: water spray, dry chemical, carbon dioxide, or foam. Use a water spray to dilute nitric acid and to absorb liberated oxides of nitrogen. (These guidelines apply to the mixture; when the components are considered separately, different precautions may apply.)

Fire Fighting: Avoid inhalation of material or combustion byproducts. Wear full protective clothing and NIOSH-approved self-contained breathing apparatus (SCBA).

Flash Point (°C): N/A

Autoignition (°C): N/A

Lower Explosive Limit (LEL): N/A

Upper Explosive Limit (UEL): N/A

Flammability Class (OSHA): N/A

6. ACCIDENTAL RELEASE MEASURES

Occupational Release: Notify safety personnel of spills. Surfaces contaminated with this material should be covered with soda ash or sodium bicarbonate to neutralize the acid. Place the neutralized material into containers suitable for eventual disposal, reclamation, or destruction.

Disposal: Refer to Section 13, Disposal Considerations.

7. HANDLING AND STORAGE

Storage: Store unopened containers of this material in a dry place at room temperature. Protect from physical damage, heat, and light, and isolate from incompatible materials. Use opened containers immediately or discard.

Safe Handling Precautions: Wear gloves and chemical safety goggles (Section 8). Engineering controls should maintain airborne concentrations below TLV (Section 8).

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Nitric Acid:

ACGIH TLV-TWA: 2 ppm or 5 mg/m³
OSHA TLV-TWA: 2 ppm or 5 mg/m³

Silver Nitrate (limits for soluble silver compounds):

ACGIH TLV-TWA: 0.01 mg/m³
OSHA TLV-TWA: 0.01 mg/m³

Silver:

ACGIH TLV-TWA: 0.1 mg/m³
OSHA TLV-TWA: 0.01 mg/m³

Ventilation: Use local or general exhaust to keep employee exposures below limits. Local exhaust ventilation is preferred because it can control contaminant emissions at the source, preventing dispersion into the general work area. Refer to the ACGIH document *Industrial Ventilation, a Manual of Recommended Practices*.

Respirator: If necessary, refer to the NIOSH document *Guide to the Selection and Use of Particulate Respirators Certified under 42 CFR 84* for selection and use of respirators certified by NIOSH.

Eye Protection: Use chemical safety goggles where dusting or splashing of solutions may occur. See OSHA standard (29 CFR 1910.133) or European Standard EN166. The employer should provide an emergency eye wash fountain and safety shower in the immediate work area.

Personal Protection: Wear appropriate gloves and protective clothing to prevent contact with skin.

9. PHYSICAL AND CHEMICAL PROPERTIES

| Nitric Acid | Silver Nitrate | Silver |
|---|---|--|
| Appearance and Odor: Colorless to slightly yellow liquid, darkens to brown upon aging and exposure to light; irritating, pungent odor. | Appearance and Odor: Large colorless crystals, or small white crystals; odorless | Appearance and Odor: Ductile, lustrous, white solid, or gray to black powder. |
| Relative Molecular Weight: 63.02 | Relative Molecular Weight: 169.87 | Relative Molecular Weight: 107.87 |
| Molecular Formula: HNO ₃ | Molecular Formula: AgNO ₃ | Molecular Formula: Ag |
| Specific Gravity: 1.0543 (10%) | Specific Gravity: 4.35 | Specific Gravity: 10.53 |
| Solvent Solubility: Decomposes in alcohol | Solvent Solubility: Soluble in glycerol, ether, benzene, and hot alcohol | Solvent Solubility: Soluble in hot sulfuric acid, nitric acid, and alkali cyanide solutions |
| Water Solubility: Soluble | Water Solubility: Highly soluble | Water Solubility: Insoluble |
| Boiling Point (°C): 86 (187°F) | Boiling Point (°C): 444 (831°F); decomposes | Boiling Point (°C): 2212 (4013°F) |
| Vapor Pressure (Pa): 946 @20°C | Vapor Pressure (Pa): Negligible at room temperature | Vapor Pressure (Pa): 101300 @ 1031°C (1888°F) |
| Vapor Density (Air=1): 2.17 | Vapor Density (Air=1): 4.4 | Vapor Density (Air=1): N/A |
| pH: 1.0 (0.1M solution) | pH: Approximately 6 | pH: N/A |

NOTE: The physical and chemical data provided are for the pure components. No physical or chemical data are available for this solution of silver and nitric acid. The actual behavior of the solution may differ from the individual components.

10. STABILITY AND REACTIVITY

Stability: X Stable Unstable

Stable at normal temperatures and pressure.

Conditions to Avoid: Contact with combustible and other incompatible materials.

Incompatible Materials:

Nitric Acid: Incompatible with numerous materials including organic materials, plastics, rubber, chlorine, and metal ferrocyanide.

Silver Nitrate: Incompatible with ammonia, strong bases, alcohols, magnesium, calcium carbide, charcoal, ammonium hydroxide, ethanol, chlorine trifluoride, phosphine, phosphorus, acrylonitrile, sulfur, phosphonium iodide, and acetylene.

Silver: Incompatible with acetylene, ammonia, strong hydrogen peroxide solutions, strong acids, tartaric acid, oxalic acid, bromoazide, chlorine trifluoride, and ethyleneimine.

Fire/Explosion Information: See Section 5.

Products of Combustion: Thermal decomposition of nitric acid or silver nitrate can produce nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO₂), and nitrous oxide (N₂O). Nitric acid mist or vapor may also be produced. Thermal decomposition of silver may release silver oxide fumes.

Hazardous Polymerization: _____ Will Occur X Will Not Occur

11. TOXICOLOGICAL INFORMATION

Route of Entry: X Inhalation X Skin X Ingestion

Nitric Acid:

Human, oral: LD_{Lo} = 430 mg/kg

Rat, oral: LD₅₀ > 90 mg/kg

Rat, inhalation: LC₅₀ (4 hrs) = 130 mg/m³

Silver Nitrate:

Man, route not reported: LD_{Lo} = 529 mg/kg

Mouse, oral: LD₅₀ = 50 mg/kg

Rat, oral: LD₅₀ = 1173 mg/kg

Silver:

Rat, oral: LD₅₀ > 2000 mg/kg

Rabbit, skin: Slightly irritating

Target Organ(s): Respiratory tract, eyes, skin, GI tract, kidneys, liver.

Mutagen/Teratogen: Nitric acid has caused birth defects in animals under experimental conditions, and has also been investigated as a possible mutagen. Silver and its compounds are not known to be human reproductive hazards.

Health Effects: See Section 3.

12. ECOLOGICAL INFORMATION

Nitric Acid, Ecotoxicity Data:

Green shore crab (*Carcinus maenas*): LC₅₀ (48 hrs) = 180,000 µg/L

Starfish (*Asterias rubens*): LC₅₀ (48 hrs) = 100,000 to 330,000 µg/L

Hooknose (*Agonus cataphractus*): LC₅₀ (48 hrs) = 100,000 to 330,000 µg/L

Brook trout (*Salvelinus fontinalis*): NR-LETH = 1,562 µg/L

Cockle (*Cerastoderma edule*): LC₅₀ (48 hrs) = 330,000 to 1,000,000 µg/L

Silver Nitrate:

Frog (*Rana hexadactyla*): LC₅₀ (72 hrs) = 25.7 µg/L

Fathead minnow (*Pimephales promelas*): LC₅₀ (24 hrs) = 21.0 µg/L

Silver:

Bluegill (*Lepomis macrochirus*): LC₅₀ (96 hrs) = 64.0 µg/L

Rainbow trout (*Oncorhynchus mykiss*): LC₅₀ (96 hrs) = 13.0 µg/L

Environmental Summary: Silver and silver nitrate are highly toxic to the majority of aquatic organisms tested. Spills must not be released to the environment.

13. DISPOSAL CONSIDERATIONS

Waste Disposal: One or more components of this mixture are classified as RCRA hazardous waste. Dispose of container and unused contents in accordance with federal, state, and local requirements for acid waste, which vary according to location. Decontaminate containers before recycling.

14. TRANSPORTATION INFORMATION

U.S. DOT and IATA: Nitric Acid Solution, Hazard Class 8, UN2031, Packing Group II

15. REGULATORY INFORMATION

U.S. REGULATIONS

CERCLA Sections 102a/103 (40 CFR 302.4):

Nitric Acid: RQ = 1000 lbs.

Silver Nitrate: RQ = 1 lb.

Silver: RQ = 1000 lbs.

SARA Title III Section 302: Nitric acid is regulated.

SARA Title III Section 304: Nitric acid is regulated.

SARA Title III Section 313: All three components are regulated.

OSHA Process Safety (29 CFR 1910.119): Nitric acid at higher concentrations (≥ 94.5%) is regulated.

SARA Title III Sections 311/312 Hazardous Categories (40 CFR 370.21):

ACUTE: Yes

CHRONIC: Yes

FIRE: No

REACTIVE: Yes

SUDDEN RELEASE: No

STATE REGULATIONS

California Proposition 65: None of the components are regulated.

CANADIAN REGULATIONS

WHMIS Classification:

Nitric Acid: C (oxidizing material), D1A (very toxic material), E (corrosive material)

Silver Nitrate: C (oxidizing material)

Silver: D2B (toxic material).

WHMIS Ingredient Disclosure List: All three components are regulated.

CEPA Domestic Substances List (DSL): All three components are regulated.

EUROPEAN REGULATIONS

Nitric Acid: O (Oxidizer), C (Corrosive)

Silver Nitrate: C (Corrosive), N (Dangerous for the Environment)

Silver: XN (Harmful); not classified in Annex I of Directive 67/548/EEC; not on a priority list.

Risk Phrases (mixture):

R23 (toxic by inhalation)

R25 (toxic if swallowed)

R34 (causes burns)

R36/37/38 (irritating to eyes, respiratory system and skin)

R50 (very toxic to aquatic organisms)

Safety Phrases (mixture):

S20/21 (when using, do not eat, drink or smoke)

S26 (in case of eye contact, rinse immediately with water and seek medical advice)

S28 (wash after contact with skin)

S45 (in case of accident or illness, see doctor; show label)

S60 (dispose of this material and its container as hazardous waste)

S61 (avoid release to the environment)

NATIONAL INVENTORY STATUS

U.S. Inventory (TSCA): All components are listed.

TSCA 12(b), Export Notification: No components are listed.

16. OTHER INFORMATION

Sources:

IUCLID Chemical Data Sheet: Nitric Acid. European Chemicals Bureau, 19 February 2000.

IUCLID Chemical Data Sheet: Silver. European Chemicals Bureau, 19 February 2000.

IUCLID Chemical Data Sheet: Silver Nitrate. European Chemicals Bureau, 19 February 2000.

PAN Pesticide Database: Nitric Acid.

U.S. National Institute for Occupational Safety and Health, *NIOSH Pocket Guide to Chemical Hazards*, June 1990 edition. DHHS (NIOSH) Publication No. 90-117.

Disclaimer: Physical and chemical data contained in this MSDS are provided only for use as a guide in assessing the hazardous nature of the material. The MSDS was prepared carefully, using current references; however, NIST does not certify the data in the MSDS. The certified values for this material are given in the NIST Certificate of Analysis.